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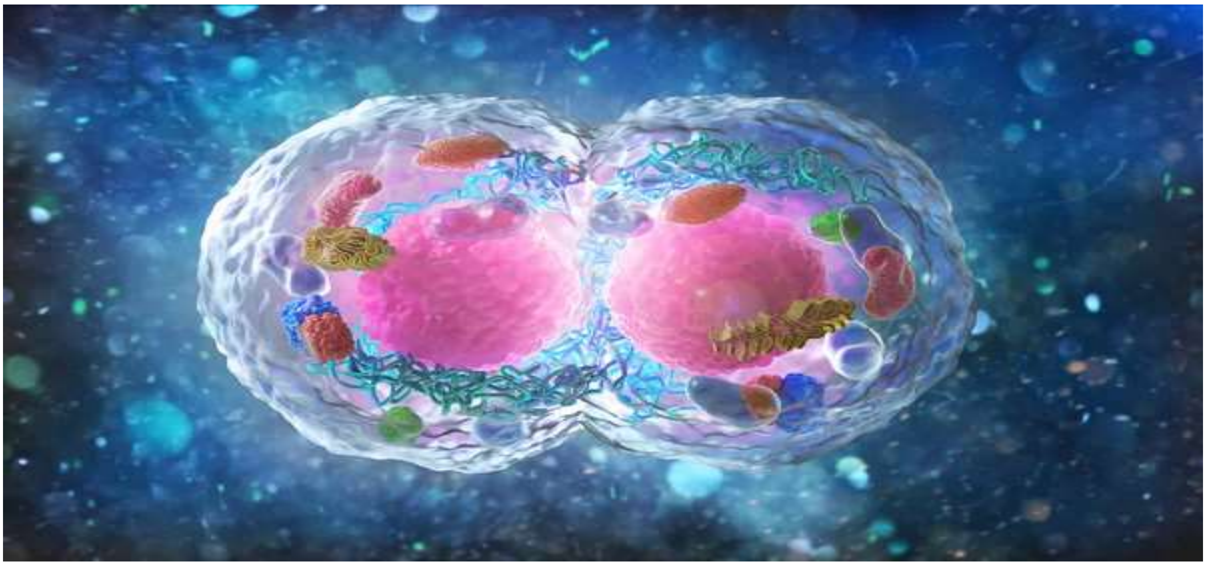
Meiosis and nucleic acid



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Meiosis :- is the form of eukaryotic cell division that produces haploid sex cells or gametes (which contain a single copy of each chromosome) from diploid cells (which contain two copies of each chromosome).Meiosis involves two sequential cycles of nuclear and cell division called meiosis I and meiosis II but only a single cycle of DNA replication.

- Meiosis I is initiated after the parental chromosomes have replicated to produce identical sister chromatids at the S phase.
- Four haploid cells are formed at the end of meiosis II. Meiotic events can be grouped under the following phases:

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Prophase I	Prophase II
Telophase I	Telophase II

How does meiosis occur?

Meiosis is characterized by two successive divisions of the nucleus (meiosis I and II) and cytoplasm, whereas the chromosomes divide only once.

Meiosis-I :-

Prophase-I

The prophase-I of meiosis-I is much longer as compared to the prophase of mitosis.

- It is further sub-divided into the following five sub-stages :

(i) Leptotene
(ii) Zygotene
iii) Pachytene
(iv) Diplotene
(v) Diakinesis

Prophase I highlights the exchange of DNA between paired chromosomes via a process called homologous recombination and the crossover at chiasmata (singular: chiasma) between non-sister chromatids. Thus, this stage is important to increase genetic variation.

This stage then ends with the disintegration of the nucleolus and the nuclear membrane.

(vi) Metaphase-I

1- The bivalents arrange themselves at the equatororial plate.

2- The homologous chromosomes arrange in such a way that all maternal or all paternal chromosomes do not get attached to same pole. In other words, some maternal and some paternal chromosomes are joined to each pole.

3- The spindle fibers are attached at the centromere of the chromosomes.

4- One centromere of a bivalent is joined to one pole and second centromere is joined to the opposite pole by the separate spindle fibers.

(vii) Anaphase-I

1- The spindle fibers shorten.

2- The centromeres of homologous chromosomes are pulled along by the spindle fibers towards the opposite poles (no division of centromere)

viii)Telophase-I

1- The separated chromosomes uncoil in the newly formed daughter nuclei.

2- The daughter nuclei have half the number of centromeres as compared to that in the parent nucleus. But, since each centromere has two chromatids.

3- The nucleous reappears and nuclear membrane forms

4- The daughter nuclei enter into the second meiotic division.

Second Meiotic Division has the same four stages

(i) Prophase II (ii) Metaphase II

(iii) Anaphase II (iv) Telophase II

(i) Prophase II

1- The chromosomes shorten and chromatids become distinct. The two chromatids of each chromosome are attached to the single centromere.

2- Formation of spindle starts.

3- Nucleolus and nuclear membrane begin to disappear.

(ii) Metaphase II

1- The chromosomes arrange themselves along the equator.

2- Formation of spindle apparatus is completed.

3- The centromere of each chromosome is attached by two spindle fibres to the opposite poles.

(iii) Anaphase II

1- The centromere in each chromosome divides so that each chromatid has its own centromere and each chromatid is now a complete chromosome.

2- The chromatids get their respective centromere and become daughter chromosomes and begin to move towards the opposite poles due to contraction of spindle fibres.

(iv) Telophase

1- On reaching the poles, the chromosomes organize themselves into haploid daughter nuclei.

2- The nucleolus and the nuclear membrane reappear.

3- Each of the four daughter nuclei has half the number of chromosomes (n) as well as half the amount of DNA as compared to the parent nucleus (2n).

Cytokinesis

1- This may occur in two successive stages, once after meiosis I and then after meiosis II, or in some instances it occurs only after meiosis II.

2- Thus after meiotic cell division four haploid cells are formed.

Nucleic acids:- are polymers of **nucleotides**.

Nucleotides:- are carbon ring structures containing nitrogen linked to a 5-carbon sugar (a ribose)

- 5-carbon sugar is either a ribose or a deoxy-ribose making the nucleotide either a ribonucleotide or a deoxyribonucleotide .
    - **In eukaryotic cells nucleic acids are either:**
    - **Deoxyribose nucleic acids (DNA)**
    - **Ribose nucleic acids (RNA)**
- **Nucleic Acid Function**

DNA :-Genetic material - sequence of nucleotides encodes different amino acids.

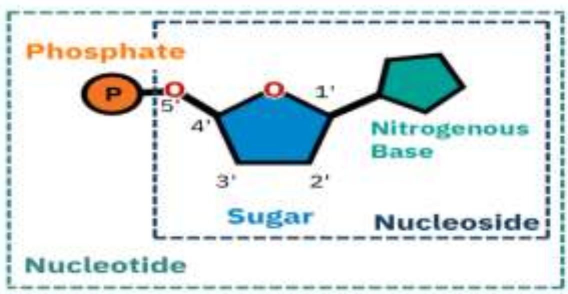
RNA :- Involved in the transcription/translation of genetic material (DNA) and genetic material in some viruses .

Nucleotide Structure

Despite the complexity and diversity of life the structure of DNA is dependent on only 4 different nucleotides.

All nucleotides are 2 ring structures composed of:

5-carbon sugar : Ribose (RNA) , Deoxyribose (DNA) and Base :- **Purine and pyrimidine** and **Phosphate group**



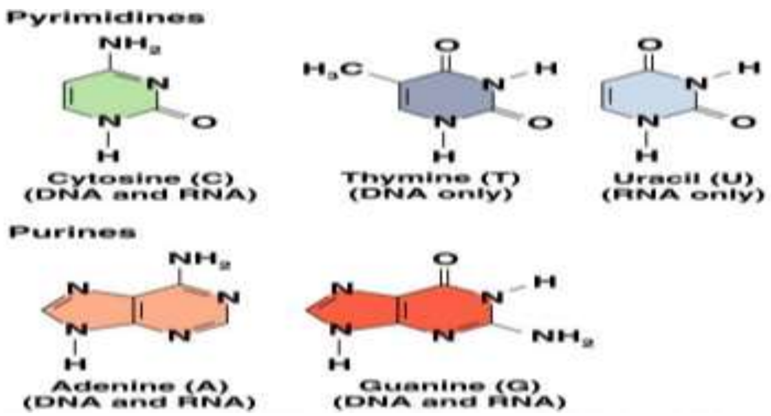
A nucleotide **WITHOUT** a phosphate group is a **NUCLEOSIDE**.

Purine and Pyrimidine

- Pyrimidine contains two pyridine-like nitrogens in a six-membered aromatic ring
- Purine has 4 N's in a fused-ring structure.
  - The nitrogen bases in nucleotides consist of two general types:

  - purines: adenine (A) and guanine (G)

  - pyrimidines: cytosine (C), thymine (T) and Uracil (U)



- Thymine is found ONLY in DNA.

- In RNA, thymine is replaced by uracil
- Uracil and Thymine are structurally similar

Nucleic Acids (DNA And RNA) Notes

DNA – **Deoxyribonucleic Acid**

- DNA controls all living processes including production of new cells – **cell division**.
- DNA carries the genetic code – **stores** and **transmits** genetic information from one **generation** to the next.
- Chromosomes are made of **DNA.**
- DNA is located in the **nucleus** of the cell.

This chemical substance is present in the nucleus of all cells in all living organisms.

DNA controls all the chemical changes which take place in cells.

The kind of cell which is formed, (muscle, blood, nerve etc) is controlled by DNA.

Base Pairing in DNA: The Watson–Crick Model

- In 1953 Watson and Crick noted that DNA consists of two polynucleotide strands, running in opposite directions and coiled around each other in a double helix
- Strands are held together by hydrogen bonds between specific pairs of bases
- Adenine (A) and thymine (T) form strong hydrogen bonds to each other.
- (G) and cytosine (C) form strong hydrogen bonds to each other .
- The strands of DNA are complementary because of H-bonding
- Whenever a G occurs in one strand, a C occurs opposite it in the other strand
- When an A occurs in one strand, a T occurs in the other.

Properties of a DNA double helix

1 The strands of DNA are antiparallel
2 The strands are complimentary
3 There are Hydrogen bond forces
4 There are base stacking interactions
5 There are 10 base pairs per turn

Ribonucleic Acid (RNA)

- RNA is much more abundant than DNA
- There are several important differences between RNA and DNA:
  - the pentose sugar in RNA is ribose, in DNA it's deoxyribose
  - in RNA, uracil replaces the base thymine (U pairs with A)
  - RNA is single stranded while DNA is double stranded
  - RNA molecules are much smaller than DNA molecules
- There are three main types of RNA:
  - ribosomal (rRNA), messenger (mRNA) and transfer (tRNA)

Types of RNA

Table 22.3 Types of RNA Molecules

Type	Abbreviation	Percentage of Total RNA	Function in the Cell
Ribosomal RNA	rRNA	75	Major component of the ribosomes
Messenger RNA	mRNA	5–10	Carries information for protein synthesis from the DNA in the nucleus to the ribosomes
Transfer RNA	tRNA	10–15	Brings amino acids to the ribosomes for protein synthesis